Set 21: Molecular Geometry

Skill 21.01: Explain the factors which effect the shapes of molecules
Skill 21.02: Be able to predict the molecular geometry of a given molecule

Skill 21.01: Explain the factors which effect the shapes of molecules

Skill 21.01 Concepts

Electrons repel one another, so when atoms come together to from a molecule, the molecule will assume the shape that keeps its different electron pairs as far apart as possible. When you predict the geometries of molecules keep this concept in mind.

In a molecule with more than two atoms, the shape of the molecule is determined by the number of electron pairs on the central atom. Variations of the standard shape occur depending on the number of bonding pairs and lone pairs of electrons present on the central atom.

Here are some things you should remember when dealing with the VSEPR model:

- Double and triple bonds are treated in the same way as single bonds in predicting overall geometry for a molecule. But multiple bonds have slightly more repulsive strength and therefore will occupy a little more space than single bonds.

- Lone electron pairs have a little more repulsive strength than bonding pairs, so lone pairs will occupy a little more space than bonding pairs.

- The more lone electrons on an atom, the greater the distortion in the molecule. This point is illustrated in the following example.

Skill 21.01 Problem 1

(a) Draw the Lewis electron-dot structure for each of the following		
NO_2	NO_2	NO_2^+
(b) List the species in order of <u>increasing</u> N-O-N bond angle. Justify your answer.		

Skill 21.02: Be able to predict the molecular geometry of a given molecule

Skill 21.02 Concepts

The shape, or geometry, of given molecule depends upon the number of atoms bonded to the central atom, along with the number of electrons on the central atom. This point is illustrated in table 1.

Table 1. Geometry of simple molecules

Bonding atoms	Lone pairs	Geometry	Bond angles	Examples
2	0	Linear	$HgCl_2$	180º
3	0	Trigonal planar	BF_3	120º
4	0	Tetrahedral	CCl_4	109.5º
5	0	Trigonal bipyramidal	PCl_5	90º & 120º
6	0	Octahedral	SF_6	90º
2	1	Bent	SO_2	<120º
3	1	Trigonal pyramidal	NI_3	<109.5º
2	2	Bent	H_2S	<109.5º
4	1	seesaw	XeO_2F_2	>90º, <120º
3	2	T-shaped	ClF_3	90º, 180º
2	3	Linear	I_3^-	180º
5	1	Square pyramidal	$XeOF_4$	<90º
4	2	Square planar	XeF_4	90º

Skill 21.02 Problem 1

Draw the Lewis structures for the following molecules. For each molecule, use table 1 to determine geometry.
(a) CH_4
(b) CO_2
(c) H_2O
(d) NH_3
(e) BeH_2
(f) SF_4
(g) SF_6
(h) BH_3

(i) XeF_4